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Received 20 October 2005; accepted 16 November 2006

Is there always a bias towards young males in road kill samples? The case in Victorian Koalas *Phascolarctos cinereus*

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Abstract

Mortality due to road trauma can have large negative impacts on some populations and often is biased towards age/sex classes that have higher rates of movement: individuals during the breeding season and juveniles while they are dispersing. A bias towards young males has been found in two previous studies of road kill Koalas in southeast Queensland. Such a bias was not found in the present study of Koala skulls from populations across Victoria. This may be due to the different Koala population structures and densities or road types and characteristics. (*The Victorian Naturalist* **123** (6) 2006, 395-399).

Introduction

Individuals of many species are killed on the roads (Trombulak and Frissell 2000; Taylor and Goldingay 2004) and this ean have large negative effects on populations of wild animals (Dufty 1994; Jones 2000; Hebblewhite *et al.* 2003; Lopez *et al.* 2003). Road trauma is known to impact some Koala populations (Backhouse and Crouch 1990; Lunney *et al.* 1996; Thompson 1996). The Phillip Island Koala population in Victoria deereased substantially between 1973 and 1988, mostly due to high mortality from road trauma (Every 1986; Baekhouse and Croueh 1990).

Mortality rates due to road trauma have been found to differ between temporal seasons (Taylor and Goldingay 2004) and may be greater in age/sex classes that have high dispersal rates or inereased activity levels (Bonnet *et al.* 1999, Inbar and Mayer 1999). For example, Coulson (1989) found that 48% of road killed Eastern Grey Kangaroos *Macropus giganteus* were 1 to 2 years of age, the age when they were dispersing. A significant bias towards road kills of two-year-old maeropods was also found by Lee *et al.* (2004). Additionally, males were more likely to be hit than females in five species of macropods, possibly beeause of their greater ranging behaviour (Coulson 1997). A high proportion of ungulate road traumas are also related to dispersal and breeding behaviour (Groot Bruinderink and Hazebroek 1996). Similar patterns of male-biased mortality caused by road trauma have been found in

Koalas (Weigler *et al.* 1987; Dique *et al.* 2003b).

Methods

Koala skulls were opportunistically collected from Victorian Koala populations and measured at several Victorian State and University Museums (Table 1). Fresh Koala carcasses also were collected opportunistically from roadsides during travel throughout Victoria (1999-2002). The populations ranged from high density with little vehicular traffic or dogs (e.g. Snake Island) to low density, probably declining populations with high traffic volumes and domestic dogs (e.g. Phillip Island).

Skulls collected from Snake Island, Framlingham and Mt Eccles were assumed to have resulted from natural mortality, as road traffic and predation by domestic dogs *Canis familiaris* are considered negligible at these sites. Skulls from other populations were allocated a cause of death including natural mortality, death resulting from road trauma or unknown cause of death. Koalas were presumed to have died from road trauma if the carcass was found within 50 m of a road (most were detected on the roadside verge). Koalas were allocated to the 'unknown cause of death' category if there was no information regarding the collection details. Skulls were pooled across all locations according to the cause of death.

All skulls were cleaned and the age of the Koala at death was estimated using a nine-point tooth wear class (TWC) scoring system (see McLean 2003). The length and width of each skull were measured and used in combination with TWC to determine the sex of the Koala (see McLean 2003).

The frequency distribution of skulls across all TWCs was assessed with Kolmogorov-Smirnov Z, 2 independent samples tests to compare age and sex-specific mortality patterns. The overall sex ratio of Koalas presumed to be killed by road trauma was compared with Chi-square tests.

Results

Mortality due to road trauma was spread over all TWCs greater than TWC I in females and TWC II in males (Fig. 1). Of the Koalas that were presumed killed by road trauma, 39% of females and 17% of males were in the older TWCs (V – VII combined); only 2.5% of the road trauma group were in TWC II. The overall sex ratio of 1:1.35 (17 males: 23 females) for Koalas presumed killed by road trauma was not significantly different from parity ($\chi^2 = 0.9$, d.f. = 1, $P > 0.05$).

There was little evidence of a difference in the pattern of age-specific mortality of male Koalas that died of natural causes compared with unknown causes, or natural causes compared with road trauma, or unknown causes compared with road trauma (Table 2). Similarly, there was little evidence of a difference in these same comparisons for females (Table 2).

Discussion

In the present study, a similar proportion of male and female skulls were collected beside roads and these were spread relatively evenly over all TWCs. Additionally, Koalas presumed killed on the road had a similar age distribution to those that died of natural causes in both males and females. The absence of young Koalas (TWC I) in the road kill sample is probably due to the fact that the skull sutures of young Koalas are not well formed, and the skulls break up more quickly than the skulls of older Koalas, rather than any suggestion that this age class is not subject to road trauma. The contribution of the older animals (TWC VI and VII) to the sample is interesting given that very few individuals of that age have been found in live Koala populations studied in Victoria (McLean 2003).

The pattern of age- and sex-specific road trauma in the present study differs from studies of Koala mortality in 'near urban' and 'heavily urbanised' environments in southeast Queensland (Weigler *et al.* 1987; Dique *et al.* 2003b) where it was found that mortality due to road trauma was male-biased. Dique *et al.* (2003b) found that 61% of the Koalas that died from road trauma were males, a significantly higher proportion than in the local population (41%, $n = 58$). Additionally, young males (2 – 4 years of age) were disproportionately represented in the road trauma group compared with the population while no

Table 1. Number of Koala skulls collected from each Victorian locality. * Sites where a proportion of the skulls measured were from koalas presumed to be killed by road trauma.

Site	# skulls	Site	# skulls	Site	# skulls
Snake Island	210	Lake Tarli Karn	2	Keilor	1
Unknown*	180	Langwarren	2	Kerang	1
Phillip Island*	101	Rosedale	2	Lang Lang	1
Boho*	65	Sandy Point	2	Launching Place	1
Brisbane Ranges	60	Somerville	2	Lima South	1
French Island	40	St Margaret's Is.	2	Macks Creek	1
Mt Eccles	32	Stony Rises	2	Mallacoota*	1
Zoo	23	Swan Hill	2	Maroondah Weir	1
Walkerville	22	Tyabb	2	Meeniyan	1
Healesville	18	Warneet	2	Mildura	1
Ararat	14	Wartook	2	Molesworth*	1
Mt Macedon*	9	Werribee Gorge	2	Monomeik	1
Wilsons Prom	9	Willung	2	Mooroduc	1
Creswick	8	Yarck*	2	Mornington	1
Woodend*	7	You Yangs	2	Mt Charlie	1
Framlingham	6	Alexandra	1	Mt Dryden	1
Grey River Reserve	5	Altona	1	Mt Robertson	1
Kennett River	5	Axedale Forest	1	North Mangalore	1
Macedon	5	Bairnsdale	1	New Gisborne	1
Bacchus Marsh	4	Bass	1	Nyora*	1
Frankston	4	Beaufort	1	Pearcedale	1
Gisborne	4	Bochara	1	Pental Island	1
Leongatha	4	Boolara	1	Port Franklin	1
Morwell	4	Broadford*	1	Rawson	1
Portland*	4	Broken River	1	Raymond Island*	1
Traralgon	4	Bullengarook	1	Romsey	1
Violet Town	4	Bunyip State Park	1	Rosebud	1
Warrandyte	4	Calder Hwy	1	Sale	1
Yarram	4	Chiltern	1	Sassafrass	1
Cranbourne	3	Cobow	1	Sprinvale South	1
Ferntree Gully	3	Corranderk	1	Strezlecki	1
Grampians	3	Dandenong	1	Tarwin Lower*	1
Kyneton	3	Darrimon	1	Toora	1
Monash	3	Deer Park	1	Tooradin	1
Mt Eliza	3	Devon North	1	Torquay	1
Mt Martha	3	Digby	1	Trentham	1
Ralph Illidge	3	Doncaster*	1	Twin Lakes	1
Riddells Creek	3	Ellenbank	1	Upper Beaconsfield	1
Yea*	3	Emerald	1	Warby Ranges	1
Buffalo	2	Fish Creek	1	Welshpool	1
Castlemaine	2	Geelong	1	Winniclad Creek	1
Chinaman Island	2	Hume Hwy	1	Woodside	1
Euroa*	2	Jerralong	1	Woori Yallock	1
Inverloch	2	Kalorama	1	Yarra River	1

such pattern was evident in females (Dique *et al.* 2003b). Also, reports and veterinary examinations of Koala road trauma in southeast Queensland were male-biased (Weigler *et al.* 1987, Nattrass and Fiedler 1996). The results of the present study also contrast with Canfield (1991) who found that young to middle-aged male Koalas were highly represented in road trauma incidents on the central northern coast of New South Wales, especially during the breeding season.

The differences between Queensland and Victoria in the road kill age and sex biases are unlikely to be due to differences between the two areas in a) dispersal patterns or b) sex-biased movements during the breeding season. Similar patterns of male-biased dispersal have been found in Queensland using radio-tracking (Gordon *et al.* 1990, Dique *et al.* 2003a) and genetic techniques (Fowler *et al.* 2000, Ellis *et al.* 2002) to those found in Victoria (Mitchell 1990b; Mitchell and Martin 1990). Male

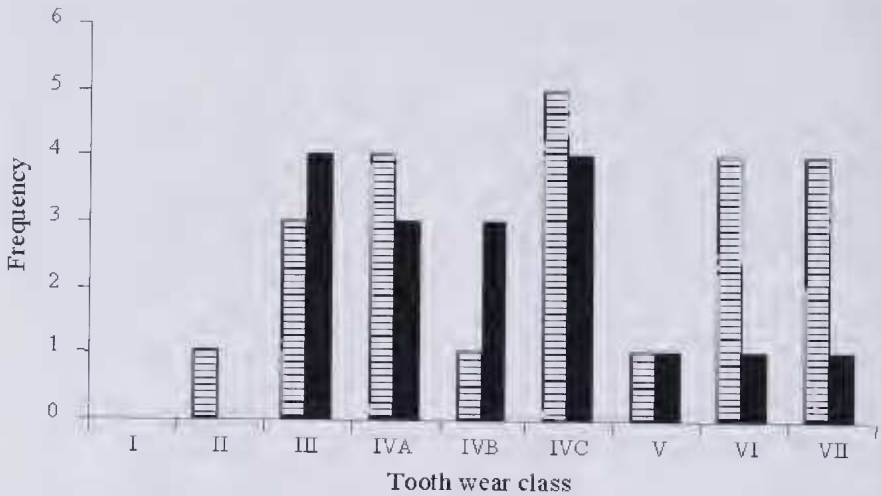

Fig. 1. Frequency of female (hatched bars) and male (filled bars) Koalas that were presumed killed as a result of road trauma in each tooth wear class, total = 40.

Table 2. Comparison of the age distributions of male and female Koala skulls between causes of death using Kolmogorov-Smirnov *Z*, 2 independent samples tests. Z is the Kolmogorov-Smirnov score, n is the sample size and P is the probability.

Comparisons	Males			Females		
	Z	n	P	Z	n	P
Natural causes and unknown causes	0.52	89, 231	0.95	0.69	81, 225	0.72
Natural causes and road trauma	0.61	89, 17	0.86	0.48	81, 23	0.98
Unknown causes and road trauma	0.76	231, 17	0.61	0.28	225, 23	1.00

Koalas also increased their overnight movement distances (Melzer and Houston 2001) and ranging behaviour (Mitchell 1990a) during the breeding season in both Queensland and Victoria.

Potential causal factors for differences in road kill frequencies and sex- and age-biases are traffic volume and speed, structure of the roadside verge and the surrounding population density (Dique *et al.* 2003b, Lee *et al.* 2004). Unfortunately, little is known about the demography or population density of the Victorian Koala populations from which the road trauma skulls were found. The reasons remain unclear as to why the road kill sample was consistently biased towards young male Koalas in other states, yet such a bias was not detected in Victoria.

Acknowledgements

This work was carried out with the permission of the Department of Sustainability and Environment (permit nos. 10 000 383, 10 001 021 and 10 001 584). I wish to thank the museums for allowing me access to their collections: Museum of Victoria (Lena Frigo and Joan Dixon, particularly) and the Zoology Department museums at the University of Melbourne, Monash University and LaTrobe University. Thanks also to the Parks Victoria offices at Brisbane Ranges National Park and Wilsons Promontory National Park for access to their skull collections. Thanks to all the Koala skull collectors, especially Ash Reed of the Phillip Island Nature Park, the Snake and French Islands Koala catching teams (particularly Ross Williamson, Les Leunig and Swampy Thomas) and the Boho South research team (particularly Kath Handasyde and Jen Martin). Many thanks to Kirstin Long, Sian McLean and Sandy Brown for assisting me to collect road kill Koalas on highways.

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Received 22 December 2005; accepted 23 November 2006

One Hundred Years Ago

EXCURSION TO WILSON'S PROMONTORY

The wood-boring larvæ of *Hepialus lignivora* were plentiful and in all stages of growth, but only one was found to have changed into the chrysalis stage. This emerged on the 12th January following. The larvæ of the well-known moth *Mamestra ewingi* were extremely plentiful, particularly on the beach at Oberon Bay, where they were seen in dozens crawling down from the grass tussocks over the sand, only to be caught by the incoming tide or eaten by the sea-birds. About 80 species of Coleoptera were taken, among which were 7 species of Buprestidæ , none of which require special mention. Among the other orders, 6 species of Cicadas were bottled, including several of the brilliant little *Cicada aurata*, which was numerous on the grass flats on the Derby River, and kept up their continuous shrill song from daylight till dark.

From *The Victorian Naturalist* **XXII** p 203, March 8, 1906